

CLAIMS

What is Claimed is:

1. A method of decreasing the shock strength needed to treat an arrhythmia comprising:

detecting an arrhythmia in the heart of a subject;

administering a therapeutic electric shock to the heart of said subject to treat said arrhythmia; and

administering a therapeutic drug selected from the group consisting of a calcium channel blocker, a calmodulin blocker, a calmodulin kinase inhibitor and an antiarrhythmic drug to said subject at a time and in an amount effective to decrease the strength of said shock required to treat said arrhythmia.

2. The method according to claim 1 wherein said calcium channel blocker is selected from the group consisting of amiodarone, bepridil, D600, diltiazem, felodipine, flunarizine, isradipine, nicardipine, nifedipine, nimodipine and verapamil.

3. The method according to claim 1 wherein said antiarrhythmic drug is selected from the group consisting of adenosine, aprindine, doxorubicin, ryanodine, ethmozin, dofetilide and ibutilide.

4. The method according to claim 1 wherein said calmodulin blocker is a calmodulin kinase inhibitor.

5. The method according to claim 1, wherein said arrhythmia is an atrial arrhythmia.

6. The method according to claim 1, wherein said arrhythmia is a ventricular arrhythmia.

7. The method according to claim 1, wherein said therapeutic electric shock is not greater than 34 joules.

8. The method according to claim 1, wherein said calcium channel blocker is administered in an amount effective to reduce defibrillation threshold shock in said subject by at least 10% as compared to a normal defibrillation threshold shock.

9. The method according to claim 8, wherein said defibrillation threshold shock is reduced by at least 20% in leading edge voltage.

10. The method according to claim 8, wherein said defibrillation threshold shock is reduced by at least 40% in energy.

11. The method according to claim 1, wherein said calcium channel blocker is administered in an amount effective to inhibit a delayed afterdepolarization caused by said shock in the absence of said calcium channel blocker.

12. A cardiac device for treating arrhythmia in a subject in need thereof, comprising:

an arrhythmia detector configured to determine if a cardiac arrhythmia is occurring from electrical activity sensed from the heart of a subject;

a controller operatively associated with said detector;

an injector operatively associated with said controller to administer a therapeutic drug selected from the group consisting of calcium channel blocker, a calmodulin blocker, a calmodulin kinase inhibitor and an antiarrhythmic drug to said subject when a cardiac arrhythmia is detected; and

a shock generator operatively associated with said controller and configured to deliver a therapeutic electric shock to the heart of said subject.

13. The cardiac device of claim 12 further comprising said controller configured to deliver said therapeutic drug at said time with said therapeutic electric shock so that the strength of said shock is decreased as compared to the shock required to treat said arrhythmia in the absence of administration of said therapeutic drug.

14. The cardiac device of claim 12 wherein said calcium channel blocker is selected from the group consisting of amiodarone, bepridil, D600, diltiazem, felodipine, flunarizine, isradipine, nicardipine, nifedipine and verapamil.

15. The cardiac device of claim 12 wherein said antiarrhythmic drug is selected from the group consisting of adenosine, aprindine, doxorubicin, ryanodine, ethmozin, dofetilide and ibutilide.

16. The cardiac device of claim 12 wherein said calmodulin blockers is a CaM kinase.

17. The cardiac device of claim 12 wherein said detector is an atrial arrhythmia detector.

18. The cardiac device of claim 12 wherein said detector is a ventricular arrhythmia detector.

19. The cardiac device of claim 12 wherein said device is an internal device.

20. The cardiac device of claim 12 wherein said device is an external device.

21. The cardiac device of claim 12 wherein said therapeutic electric shock is not greater than 34 joules.

22. A cardiac device comprising:

- a sensing electrode positioned within a subject's heart configured to measure signals from said subject's heart;

- a power supply;

- a controller operatively associated with said sensing electrode;

- a plurality of electrodes operatively associated with said controller configured to deliver a therapeutic electric shock to said subject's heart;

- a catheter operatively associated with said controller configured to deliver a therapeutic amount of a therapeutic drug selected from the group consisting of calcium channel blocker, a calmodulin blocker, a calmodulin kinase inhibitor and an antiarrhythmic drug to said subject.

23. The cardiac device of claim 22 wherein said plurality of electrodes configured for sensing cardiac signals determine if a subject's heart is undergoing an arrhythmia or a fibrillation.

24. The cardiac device of claim 22 wherein said calcium channel blocker is selected from the group consisting of amiodarone, bepridil, D600, diltiazem, felodipine, flunarizine, isradipine, nicardipine, nifedipine, nimodipine and verapamil.

25. The cardiac device of claim 22 wherein said antiarrhythmic drug is selected from the group consisting of adenosine, aprindine, doxorubicin, ryanodine, ethmozin, dofetilide and ibutilide.

26. The cardiac device of claim 22 wherein said calmodulin blockers is a CaM kinase.

27. The cardiac device of claim 22 wherein said device is internal.

28. The cardiac device of claim 22 wherein said device is external.

29. A method of decreasing the shock strength needed to treat an arrhythmia comprising:

detecting an arrhythmia in the heart of a subject;

administering a therapeutic electric shock to the heart of said subject to treat said arrhythmia;

administering a therapeutic drug selected from the group consisting of a calcium channel blocker, a calmodulin blocker, a calmodulin kinase inhibitor and a first antiarrhythmic drug to said subject at a time and in an amount effective to decrease the strength of said shock required to treat delayed afterdepolarizations; and

administering a second antiarrhythmic drug at a time and in an amount effective to prolong the refractory period.

30. The method according to claim 29 wherein said calcium channel blocker is selected from the group consisting of amiodarone, bepridil, D600, diltiazem, felodipine, flunarizine, isradipine, nicardipine, nifedipine, nimodipine and verapamil.

31. The method according to claim 29 wherein said first antiarrhythmic drug is selected from the group consisting of adenosine, aprindine, doxorubicin, ryanodine, and ethmozin

32. The method according to claim 29 wherein said second antiarrhythmic drug is selected from the group consisting of dofetilide and ibutilide.

33. The method according to claim 29 wherein said calmodulin blockers is a CaM kinase.

34. A cardiac device for treating arrhythmia in a subject in need thereof, comprising:

an arrhythmia detector configured to determine if a cardiac arrhythmia is occurring from electrical activity sensed from the heart of a subject;

a controller operatively associated with said detector;

an injector operatively associated with said controller to administer a therapeutic drug selected from the group consisting of calcium channel blocker, a calmodulin blocker, a calmodulin kinase inhibitor and a first antiarrhythmic drug to said subject when a cardiac arrhythmia is detected, wherein said injector operatively associated with said controller administers a second antiarrhythmic drug; and

a shock generator operatively associated with said controller and configured to deliver a therapeutic electric shock to the heart of said subject.

35. The cardiac device of claim 34 wherein said calcium channel blocker is selected from the group consisting of amiodarone, bepridil, D600, diltiazem, felodipine, flunarizine, isradipine, nicardipine, nifedipine, nimodipine and verapamil.

36. The cardiac device of claim 34 wherein said first antiarrhythmic drug is selected from the group consisting of adenosine, aprindine, doxorubicin, ryanodine, and ethmozin

37. The cardiac device of claim 34 wherein said second antiarrhythmic drug is selected from the group consisting of dofetilide and ibutilide.

38. The cardiac device of claim 34 wherein said calmodulin blockers is a CaM kinase.

39. The cardiac device of claim 34 wherein said device is an internal device.

40. The cardiac device of claim 34 wherein said device is an external device.

41. A system for treating an arrhythmia comprising:
a processor to detect a fibrillation event;
a defibrillation source, wherein a therapeutic shock is administered after the processor detects the fibrillation event;

a drug reservoir comprising a therapeutic drug selected from the group consisting of a calcium channel blocker, a colmodulin blocker and a calmodulin kinase inhibitor, wherein the therapeutic drug is administered proximate in time with the therapeutic shock and wherein the processor is configured to determine the amount of the therapeutic drug to be administered and the level of shock to be produced.

42. The system according to claim 41, wherein the fibrillation event is an atrial arrhythmia event.

43. The system according to claim 41, wherein the fibrillation event is a ventricular arrhythmia event.

44. The system according to claim 41 wherein said calcium channel blocker is selected from the group consisting of amiodarone, bepridil, D600, diltiazem, felodipine, flunarizine, isradipine, nicardipine, nifedipine, nimodipine and verapamil.

45. The system according to claim 41 wherein said antiarrhythmic drug is selected from the group consisting of adenosine, aprindine, doxorubicin, ryanodine, ethmozin, dofetilide and ibutilide.

46. The system according to claim 41 wherein said calmodulin blockers is a CaM kinase.

47. A cardiac device for treating an arrhythmia in a subject in need thereof, comprising:

an arrhythmia detector configured to determine if the subject is likely to experience an arrhythmia;

a controller operatively associated with said detector;

an injector operatively associated with said controller to administer a therapeutic drug, said therapeutic drug selected from the group consisting of calcium channel blocker, a calmodulin blocker, a calmodulin kinase inhibitor and an antiarrhythmic drug to said subject.

48. The cardiac device of claim 34 wherein said calcium channel blocker is selected from the group consisting of amiodarone, bepridil, D600, diltiazem, felodipine, flunarizine, isradipine, nicardipine, nifedipine, nimodipine and verapamil.